

UNITED STATES PATENT APPLICATION

Of

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and

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for

**METHODS AND SYSTEMS FOR
INDEPENDENTLY CONTROLLING THE PRESENTATION SPEED
OF DIGITAL VIDEO FRAMES AND DIGITAL AUDIO SAMPLES**

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1 The audio component of a digital television signals includes a sequence of "samples",
2 each sample representing the amplitude of a represented sound wave at a particular point in
3 time. If each sample is represented by one byte (8 bits) of memory, the measured sound
4 amplitude may be digitized to 2^8 (i.e., 256) different amplitude levels thereby fairly accurately
5 representing the amplitude of the actual measured sound. If each sample is represented by 2
6 bytes (16 bits) of memory, the measured sound amplitude may be digitized to 2^{16} (i.e., 65,536)
7 different amplitude levels thereby giving the sample a higher degree of fidelity with the
8 amplitude of the actual measured sound. Digital television stations typically transmit audio
9 samples for a given program at a sampling rate of 48,000 samples per second. This high
10 sampling rate permits for the fairly accurate representation of all sounds within the audible
11 frequency spectrum of a human being.

12 Thus, in digital television, video data for a given program is transmitted in the form of
13 frames at a certain frame rate and audio data for a given program is transmitted in the form of
14 samples a certain sampling rate. Video data and audio data are received on average at the same
15 rate that the data is transmitted.

16 It is critical that the video frames and audio samples be presented at the same rate as the
17 data is transmitted. If the video and audio are presented too quickly, the buffer within the
18 receiver will run out of video and audio data resulting in the need for the receiver to wait for the
19 next data. However, the next image frame or audio sample should be presented at a
20 predetermined time after the previous image was shown to maintain a relatively constant frame
21 and sample presentation rate. During this waiting period, if the next image frame or audio
22 sample is not received before the appointed presentation time, the last received image frame and
23 audio sample may be repeated often resulting in a noticeable presentation degradation. If the

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invention. The advantages of the invention may be realized and obtained by means of the instruments and combinations particularly pointed out in the appended claims. These and other features of the present invention will become more fully apparent from the following description and appended claims, or may be learned by the practice of the invention as set forth hereinafter.

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Year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	2053	2054	2055	2056	2057	2058	2059	2060	2061	2062	2063	2064	2065	2066	2067	2068	2069	2070	2071	2072	2073	2074	2075	2076	2077	2078	2079	2080	2081	2082	2083	2084	2085	2086	2087	2088	2089	2090	2091	2092	2093	2094	2095	2096	2097	2098	2099
1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	2053	2054	2055	2056	2057	2058	2059	2060	2061	2062	2063	2064	2065	2066	2067	2068	2069	2070	2071	2072	2073	2074	2075	2076	2077	2078	2079	2080	2081	2082	2083	2084	2085	2086	2087	2088	2089	2090	2091	2092	2093	2094	2095	2096	2097	2098	2099	

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Figure 2 schematically illustrates the internal physical components of the receiver of Figure 1;

Figure 3 schematically illustrates various modules of the receiver of Figure 1 that operate to independently control a video clock and an audio clock associated with the receiver;

Figure 4 illustrates a flowchart of a method of independently controlling the video and audio clocks;

Figure 5A illustrates a data structure of a digital packet having a program clock reference; and

Figure 5B illustrates a data structure of a digital packet having a program clock reference and an added local time stamp.

Figure 1. The effect of the concentration of the *Agrobacterium* suspension on the transformation efficiency of *Agrobacterium* strains. The *Agrobacterium* strains were grown in the YEA medium for 24 h at 28 °C. The cell concentration of the strains was adjusted to 10⁸ cells/ml. The cell suspension was mixed with the plant tissue and incubated for 24 h at 28 °C. The plant tissue was then cultured on the selective medium. The transformation efficiency was determined as the number of transformants per 100 mg of plant tissue. The data are the mean ± SD of three independent experiments.

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In one embodiment, steps according to the present invention are embodied in machine-executable software instructions, and the present invention is carried out in a processing system by a processor executing the instructions, as will be described in greater detail below. In other embodiments, hardwired circuitry may be used in place of, or in combination with, software instructions to implement the present invention.

The present invention may be implemented in a wide-variety of receiver systems. One such receiver system is described herein for illustrative purposes only. In the example system, a set-top box is connected to a television, one or more servers over the Internet, and to a television programming source. The receiver system optionally includes a processing system that executes browser software to enable a user to browse through World-Wide Web pages displayed on the television using a remote control device. It should be noted, however, the access to the Internet is not a required feature of the present invention.

In one embodiment, the present invention is included in a system known as WebTV™ (WebTV), which uses a standard television set as a display device for browsing the Web, which connects to a conventional network, such as the Internet, using standard telephone, ISDN, or similar communication lines, and which is connected to a television programming source. In accordance with the present invention, a user of a WebTV client system can utilize WebTV network services provided by one or more remote WebTV servers. The WebTV network services are used in conjunction with software running in a WebTV client system to browse the Web, send electronic mail, and to make use of the Internet in various other ways. The WebTV servers function as proxies by retrieving, from a remote server, Web pages, television programming, or other data requested by a WebTV client system and then transmitting the requested information to the WebTV client system.

Figure 1 illustrates a configuration 100 of a WebTV network which represents a suitable operating environment for the present invention. A WebTV receiver 102 receives a television programming signal from either a remote server 108 over a network infrastructure 106 such as the Internet and/or from another television programming source 112 such as conventional television terrestrial airwave, cable, or satellite broadcasters.

1 The particular source of the television programming is not important to the present
2 invention. The only requirement of the source is its ability to transmit or relay television
3 programming. It is anticipated that the principles of the present invention may be applied to
4 television broadcasts or multicasts over the Internet as well. No matter what the source of the
5 television programming, the television programming, when tuned, is ultimately presented on the
6 presentation device 114 which may be a standard television set or a computer monitor with an
7 accompanying speaker.

8 In this description and in the claims, a "television program" is to be broadly construed as
9 including any signal that has both a video component and an audio component. Furthermore, a
10 "program clock reference" is defined to include any indication, express or implied, of a
11 reference time corresponding to the television program transmitted.

12 Figure 2 shows the internal physical components of the receiver 102. Operation of the
13 receiver 102 is controlled by a CPU 202, which is coupled to an Application-Specific Integrated
14 Circuit (ASIC) 204. The CPU 202 executes software designed to implement features of the
15 present invention. ASIC 204 contains circuitry which is used to implement certain functions of
16 the receiver 102. ASIC 204 is coupled to an audio digital-to-analog converter 206 which
17 provides audio output to presentation device 114. In addition, ASIC 204 is coupled to a video
18 encoder 208 which provides video output to the presentation device 114. The receiver 102 also
19 includes an input interface for receiving control input from a user. For example, the receiver
20 102 includes an IR interface 210 that detects input infrared signals transmitted by a remote
21 control. The IR interface 210 responds to such user input by providing corresponding electrical
22 signals to ASIC 204. A modem 212 is coupled to ASIC 204 to provide connections to the
23 network infrastructure 106 in cases when the television programming is received over the

1 Internet. Other connector devices may be used as appropriate to accommodate the particular
2 medium for connecting to the remote server 108 over the network infrastructure 106. For
3 example, an Ethernet card may be used when connecting to the remote server 108 over an
4 Ethernet.

5 The receiver 102 also includes one or more memory devices. For example, the receiver
6 102 might include a mask Read Only Memory (ROM) 214, a Flash memory 216, a Random
7 Access Memory (RAM) 218 and/or a mass storage device 220. Flash memory 216 is a
8 conventional flash memory device that can be written to (programmed) and erased
9 electronically. Flash memory 216 provides storage of browser software and or data needed to
10 access remote servers 208. The mass storage device 220 may be used to input software or data
11 to the client or to download software or data received over the network infrastructure 106. The
12 mass storage device 220 includes any suitable medium for storing machine-executable
13 instructions, such as magnetic disks, optical disks, and the like.

14 In traditional television programming broadcasting such as terrestrial airwave, cable and
15 satellite, the broadcast signal includes multiple channels of programming. In order to obtain the
16 desired channel, the desired channel must first be tuned from the broadcast signal. The
17 receiver 102 includes a tuner 222 that tunes the desired channel from the broadcast signal. The
18 tuner 222 then provides the tuned signal to a demodulator 224 which demodulates the signal for
19 further processing by the ASIC 204.

20 Figure 3 illustrates several modules that are implemented in hardware and/or software in
21 the receiver 102. The operation of the modules shown in Figure 3 will be described by reference
22 to Figure 4 which shows a method in accordance with the present invention. First, the receiver
23 102 receives a television programming signal that includes video signals and audio signals (step

1 410 of Figure 4). The tuner 222 then tunes to at least one video signal and at least one audio
2 signal (step 420).

3 The video and audio signals may be from the same channel as in conventional television
4 viewing in which the audio corresponds to the video. However, the video and audio signals may
5 also be from different channels. For example, a screen-in-screen television may show, in large
6 view, the video from the video signal while the audio from the audio signal corresponds to the
7 smaller screen of video from a different channel. Thus, the video and audio signals may be from
8 different channels and thus may be unrelated.

9 The demodulator then demodulates digital packets from the video and audio signals
10 (also step 420) so that the packets may be evaluated digitally. Often, these digital packets will
11 include a broadcaster-provided program clock reference that may be used in timing the
12 presentation of the channel. By comparing the program clock reference to the local time, the
13 receiver determines whether or not to speed up or slow down the local clock so as to present the
14 channel at the same rate as it is being transmitted.

15 Figure 5A illustrates an example data structure of a digital packet 500 that may be
16 processed using the structure of Figure 3 and the method of Figure 4. The digital packet 500
17 includes a header field 501 that includes the program clock reference 502. The digital packet
18 500 also includes a body field 503 that includes the actual video or audio data that is to be
19 presented. The data structure 500 is just one example of the data structure.

20 The flowchart of Figure 4 then branches showing processing of a digital audio packet in
21 the left branch, and showing processing of a digital video packet in the right branch. The
22 remainder of the method of Figure 4 which is now described represents an example of a step for
23 independently controlling a video clock that controls the timing of the video presentation speed

1 of the video information represented by the plurality of digital video packets, and an audio clock
2 that controls the timing of the audio presentation speed of the audio represented by the plurality
3 of digital audio packets

4 Regardless of whether the digital packet is a digital video or audio packet, the receiver
5 102 adds a local time stamp to the digital packet (step 430 for video packets, and step 435 for
6 audio packets). A "local time stamp" is defined as any indication of the time reference of a local
7 clock that controls presentation speed. This local time stamp may be added to the digital packet
8 in any fashion so long as it can later be read from the digital packet.

9 Figure 5B illustrates the example data structure of the digital packet 500 in which a local
10 time stamp field 504 is concatenated to the original data structure. This local time may be
11 concatenated by the local time concatenator 310 of Figure 3. The augmented data structure is
12 represented by 500'. This local time stamp 504 is added to the digital packet 500 at a relatively
13 constant time period after the digital packet 500 is received by the receiver 102. For example,
14 the local time stamp 504 may be added to the digital packet 500 immediately after the relatively
15 constant time period processes of tuning and demodulating (step 420) the digital packet 500.

16 The addition of the local time stamp 504 to the digital packet 500 at a relatively constant
17 time period after the digital packet 500 is received allows for variable time processes to occur
18 before the receiver 102 evaluates the program clock reference 502 to determine whether the
19 speed of the local clock needs to be adjusted. This optional variable process(es) is represented
20 in Figure 3 by dotted box 320. Although adding the local time stamp allows for variable time
21 processes to be performed before the program clock reference is evaluated, the addition of the
22 local time stamp is not necessary to the operation of the invention.

23 At some point, whether it be after variable time processes or not, the local time stamp

1 504, if any, and the program clock reference are read from the digital packet 500 (step 440 for
2 video packets and step 445 for audio packets). The program clock reference is then evaluated
3 by, for example, comparing the program clock reference to the local time stamp (step 450 for
4 video packets and step 455 for audio packets) if such a local time stamp exists. This may be
5 accomplished by the comparator 330 of Figure 3. If there is not such local time stamp, the
6 comparator 330 may compare the program clock reference to the local time that the comparator
7 330 is aware of.

8 The remainder of the method operates to independently control the video clock 350 and
9 the audio clock 370 based on the program clock references. For example, in evaluating a
10 program clock reference in a video packet, if the local time (as represented by the local time
11 stamp or as represented by the local time known to the comparator) indicates the video
12 presentation is ahead of schedule as when the video buffer is in danger of being depleted (YES
13 in decision block 460), then the comparator 330 signals a video clock control 340 to slow down
14 the local video clock 350 (step 470). On the other hand, if the local time indicates the video
15 presentation is behind schedule as when the video buffer is in danger of overflowing (NO in
16 decision block 460 and YES in decision block 480), then the comparator 330 signals the video
17 clock control 340 to speed up the local video clock 350 (step 490). If the local time indicates
18 that the video presentation is neither significantly behind nor ahead of schedule (NO in both
19 decision blocks 460 and 480), then the comparator does not signal the video clock control to
20 make any video presentation speed adjustments. As the stream of video packets are received
21 and evaluated by the receiver 102, the comparator may evaluate a number of program clock
22 references each second. Thus, the comparator has the opportunity to adjust the video
23 presentation speed often so that the video presentation speed does not vary much ahead of or

1 behind schedule.

2 The structure of Figure 3 also operates to independently control the audio presentation
3 speed. For example, in evaluating the program clock reference within an audio packet, if the
4 local time indicates the audio presentation is ahead of schedule as when the audio buffer is in
5 danger of being depleted (YES in decision block 465), then the comparator 330 signals an audio
6 clock control 360 to slow down the local audio clock 370 (step 475). On the other hand, if the
7 local time indicates the audio presentation is behind schedule as when the audio buffer is in
8 danger of overflowing (NO in decision block 465 and YES in decision block 485), then the
9 comparator 330 signals the audio clock control 360 to speed up the local audio clock 370 (step
10 495). If the local time indicates that the audio presentation is neither significantly behind nor
11 ahead of schedule (NO in both decision blocks 465 and 485), then the comparator does not
12 signal the audio clock control to make any audio presentation speed adjustments. The
13 comparator has the opportunity to adjust the audio presentation speed often so that the audio
14 presentation speed also does not vary much ahead of or behind schedule.

15 Thus, the present invention retains the advantage of the prior art in that the receiver
16 buffer rarely depletes or overflows thereby resulting in high picture and audio quality. In
17 addition, the present invention enables for the independent control of the audio and video
18 presentation speeds. Thus, the video clock may be speed up while the audio clock is slowed
19 down, and vice versa.

20 This independent control of the presentation speeds of the video and audio information
21 may be beneficial when the video is being provided from one program source and the audio is
22 provided from another program source. For example, a viewer might watch a football game, but
23 instead of listening to the accompanying football commentary, the viewer may listen to the local

1 news. In addition, the viewer may listen to broadcasts having different sampling rates than a
2 television broadcast such as, for example, music broadcasted from a compact disc source. Thus,
3 a viewer may watch a football game while listening to music rather than football commentary.
4 By separately controlling the presentation speed of the digital video frames and digital audio
5 samples, the video and audio presentation remains high quality even if presented from different
6 programs.

7 The above describes methods and systems for controlling the audio and video
8 presentation speeds independently. The present invention may be embodied in other specific
9 forms without departing from its spirit or essential characteristics. The described embodiments
10 are to be considered in all respects only as illustrative and not restrictive. The scope of the
11 invention is, therefore, indicated by the appended claims rather than by the foregoing
12 description. All changes which come within the meaning and range of equivalency of the claims
13 are to be embraced within their scope.

14 What is claimed and desired to be secured by United States Letters Patent is:
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